November 2025
M.Sc.
First Semester
CORE – 01
PHYSICS
Course Code: MPHC 1.11
(Classical Mechanics)

Total Mark: 70 *Pass Mark: 28*
Time: 3 hours

Answer five *questions, taking* one *from each unit.*

UNIT–I

1. (a) Formulate the theory of the calculus of variation for the various paths traversed by a particle with an appropriate figure. 7
   (b) Compute the shortest distance between two points in a plane. 7

2. (a) Show that a force acting on the particle is derivable from a potential dependent on velocity. 7
   (b) Consider a holonomic conservative system with one degree of freedom undergoing scleronomous constraint and apply the Lagrange equations of motion to obtain its acceleration. 7

UNIT–II

3. (a) Define central force. Apply the Lagrange equation of motion to show velocity with which the centre of mass moves is constant. 1+6=7
   (b) Apply Lagrangian approach to show that the areal velocity of a planet is always a constant. 7

4. (a) Construct an orthogonal space set of axes with its respective unit vector so as to carry out a transformation from space set of axes to body set of axes and obtain the representation to show that the matrix of a complete transformation is the product of three successive matrix of transformation. 8
   (b) Derive the secular equation of inertia tensor. 6

UNIT–III

5. (a) Formulate the theory of small oscillation by applying the Lagrange equation of motion and show that there is simultaneous linear homogeneous equation which can be solved for $(n-1)$ unknowns, if and only the determinant of the coefficient vanishes. 10

   (b) Derive an expression for the potential energy of a mechanical system about a point of stable equilibrium. 4

6. (a) Apply the theory of small oscillation to evaluate the normal coordinates of a parallel pendulum. 9

   (b) Determine the frequency for a double pendulum undergoing small oscillation. 5

UNIT–IV

7. (a) Formulate the Lorentz transformation equation by using the concept of Kronecker delta function when the transformation in the Minkowski space is similar to the orthogonal transformation in three-dimensional space for two uniformly moving systems whose origin coincides at the initial time. 10

   (b) Establish the covariant Lagrangian formulation for a free particle. 4

8. (a) Show that the velocity of light added to the velocity of light gives velocity of light in relativistic physics. 8

   (b) Based on the Lagrangian formulation of relativistic mechanics, obtain the relativistic equation of motion. 6

UNIT–V

9. (a) What are Poisson brackets? Write three properties of Poisson brackets and prove them. 1+9=10

   (b) Obtain the condition for a transformation to be canonical. 4

10. (a) Show that Poisson bracket is invariant with respect to canonical transformation. 6

    (b) Derive the equation of motion in Poisson bracket form. 5

    (c) Briefly explain the Hamilton-Jacobi method. 3
